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Jones et al.

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(54) **CONNECTOR PIN**

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(57) **ABSTRACT**

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F16B 21/02 (2006.01)

A connector pin includes a stem extending between a head
and an opposite foot. The stem includes a neck having a
plurality of sections which may be planar forming edges. A
retention member including a collar and arms extending
therefrom is retained around said pin, the inner surface of the
collar correspondingly configured to the sections and edges
of the neck for a frictional fit. The pin is insertable and
retained within a receiver in overlapping mats. Pockets in
the receiver hold the retention member arms and prevent
rotational motion of the retention member. The pin is
selectively movable relative to the retention member by
rotational motion by application of force to the pin sufficient
to overcome the threshold level of friction holding the
sections of the neck at the collar. Locking the pin is achieved
when extension members of the pin foot are misaligned with
the retention member arms.

(52) **U.S. Cl.**
CPC **F16B 5/0621** (2013.01); **F16B 21/02**
(2013.01)

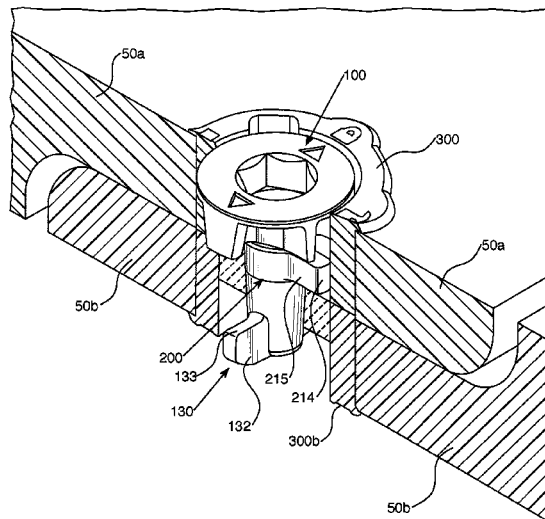
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CPC F16B 5/0621; F16B 21/02; F16B 21/04;
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25 Claims, 8 Drawing Sheets



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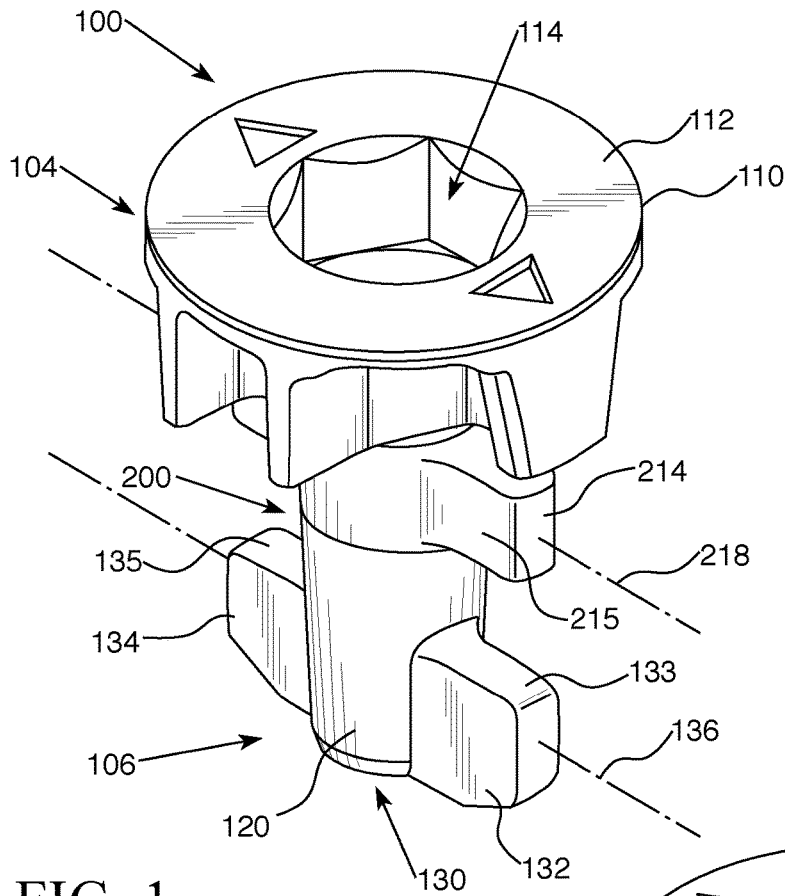


FIG. 1

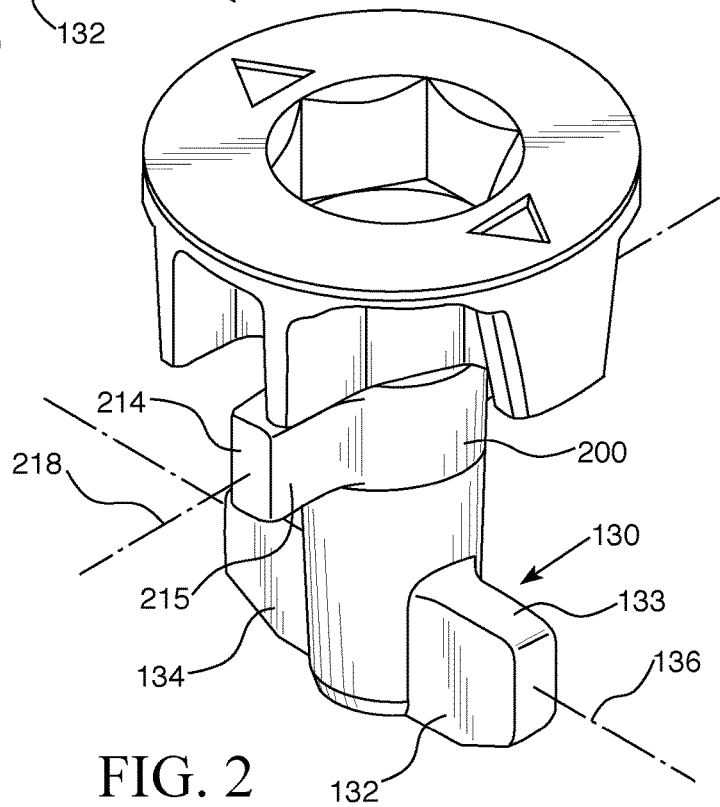


FIG. 2

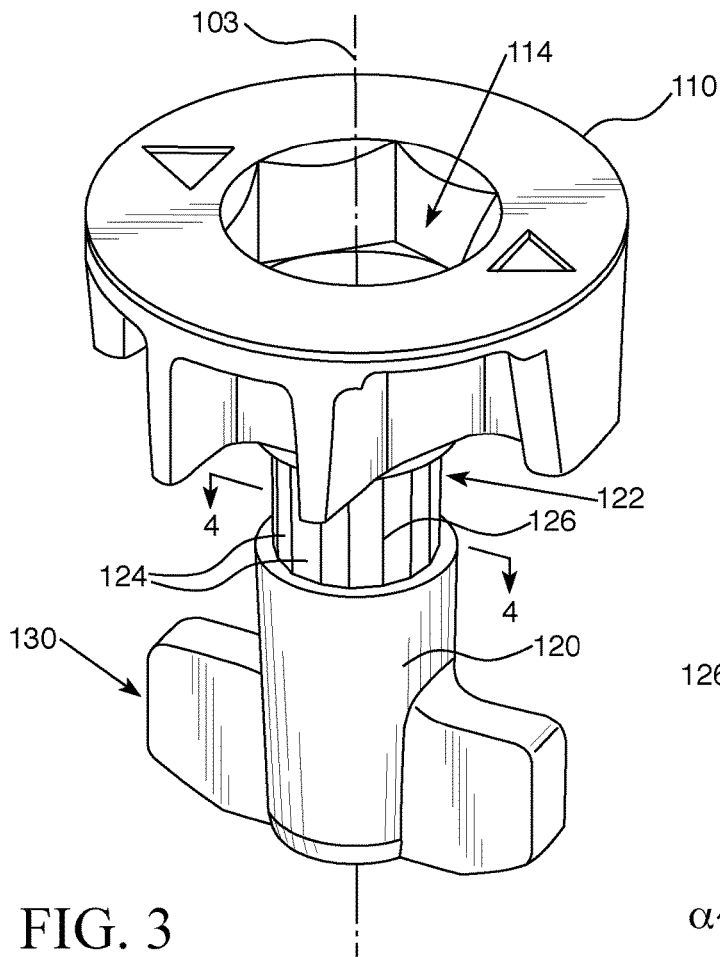


FIG. 3

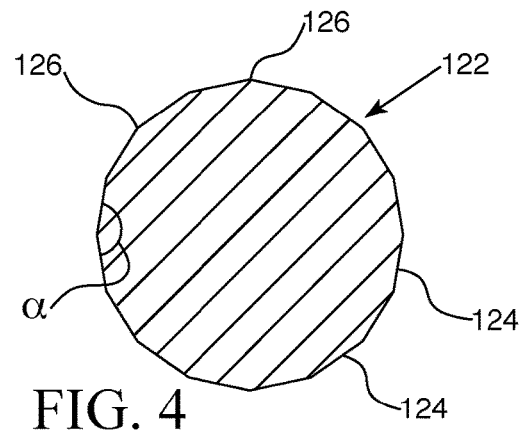


FIG. 4

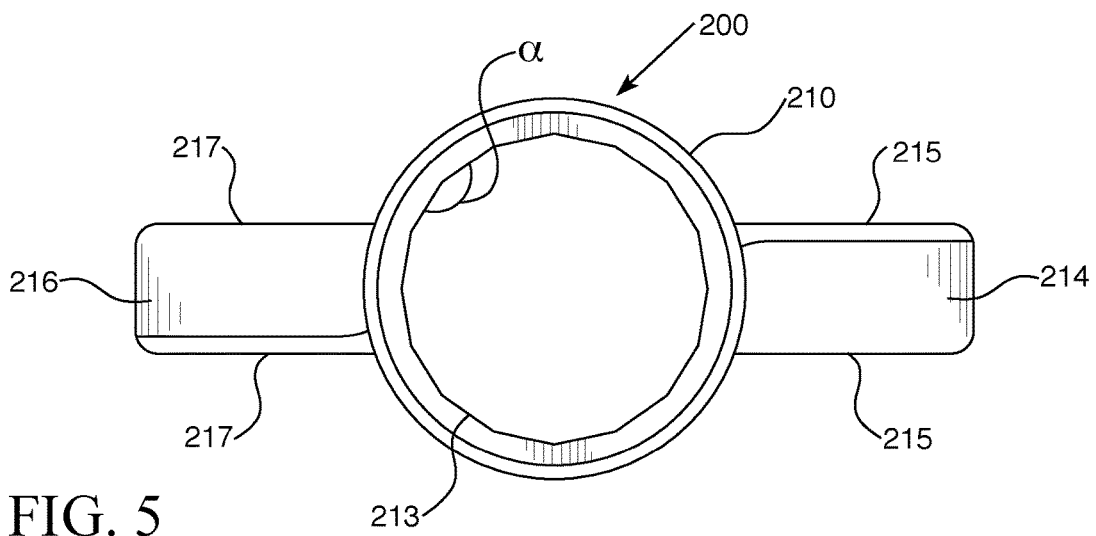


FIG. 5

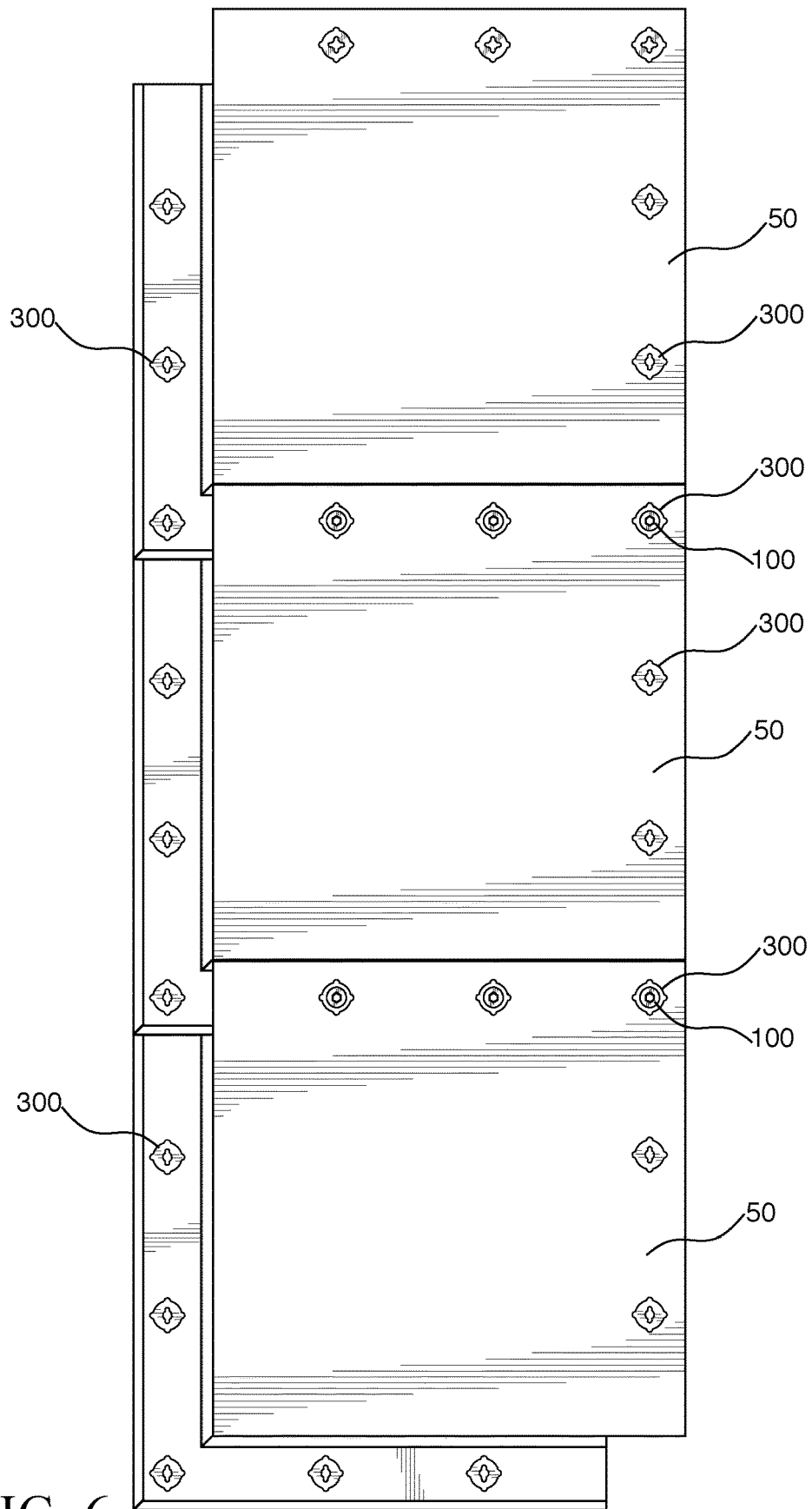


FIG. 6

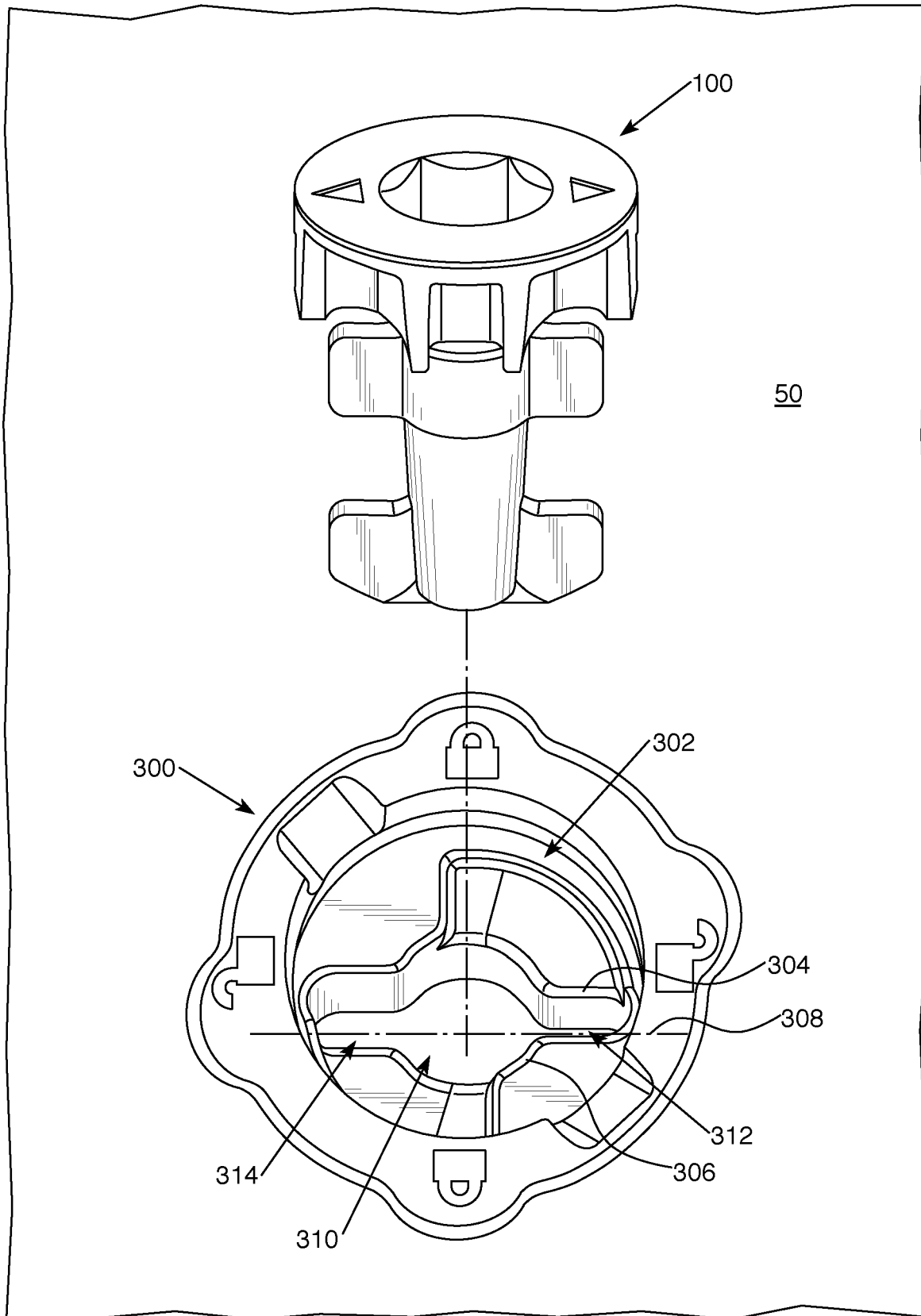


FIG. 7

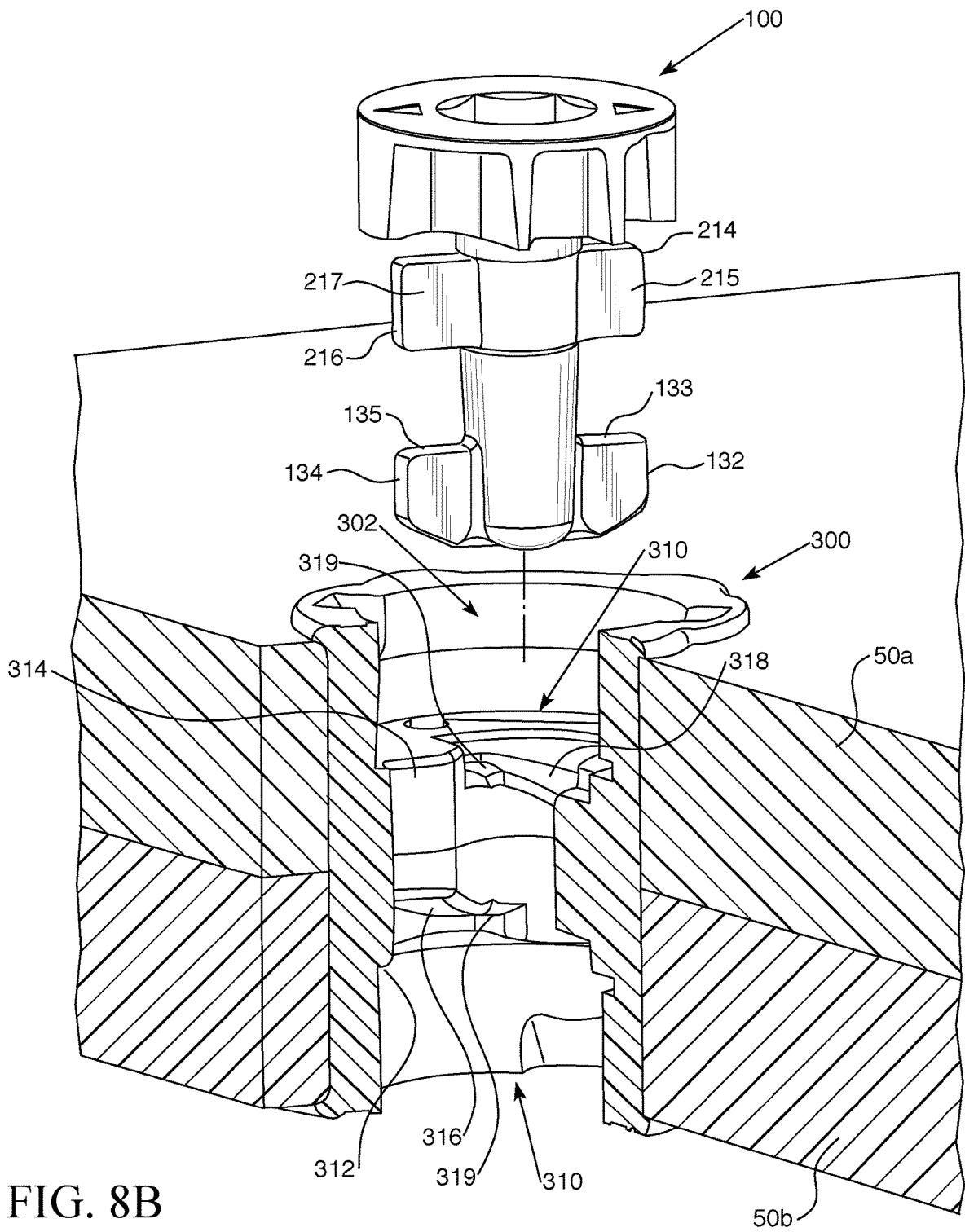


FIG. 8B

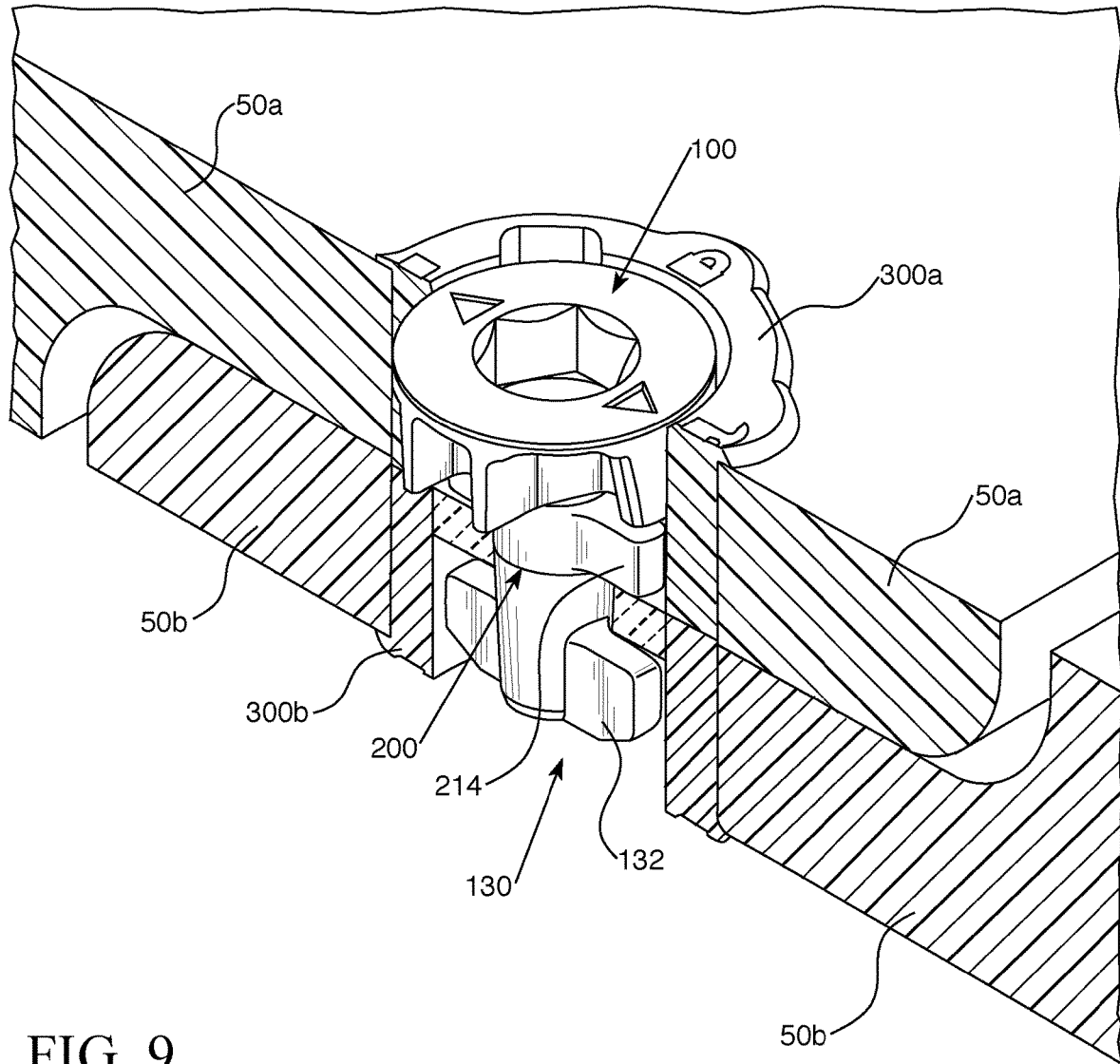


FIG. 9

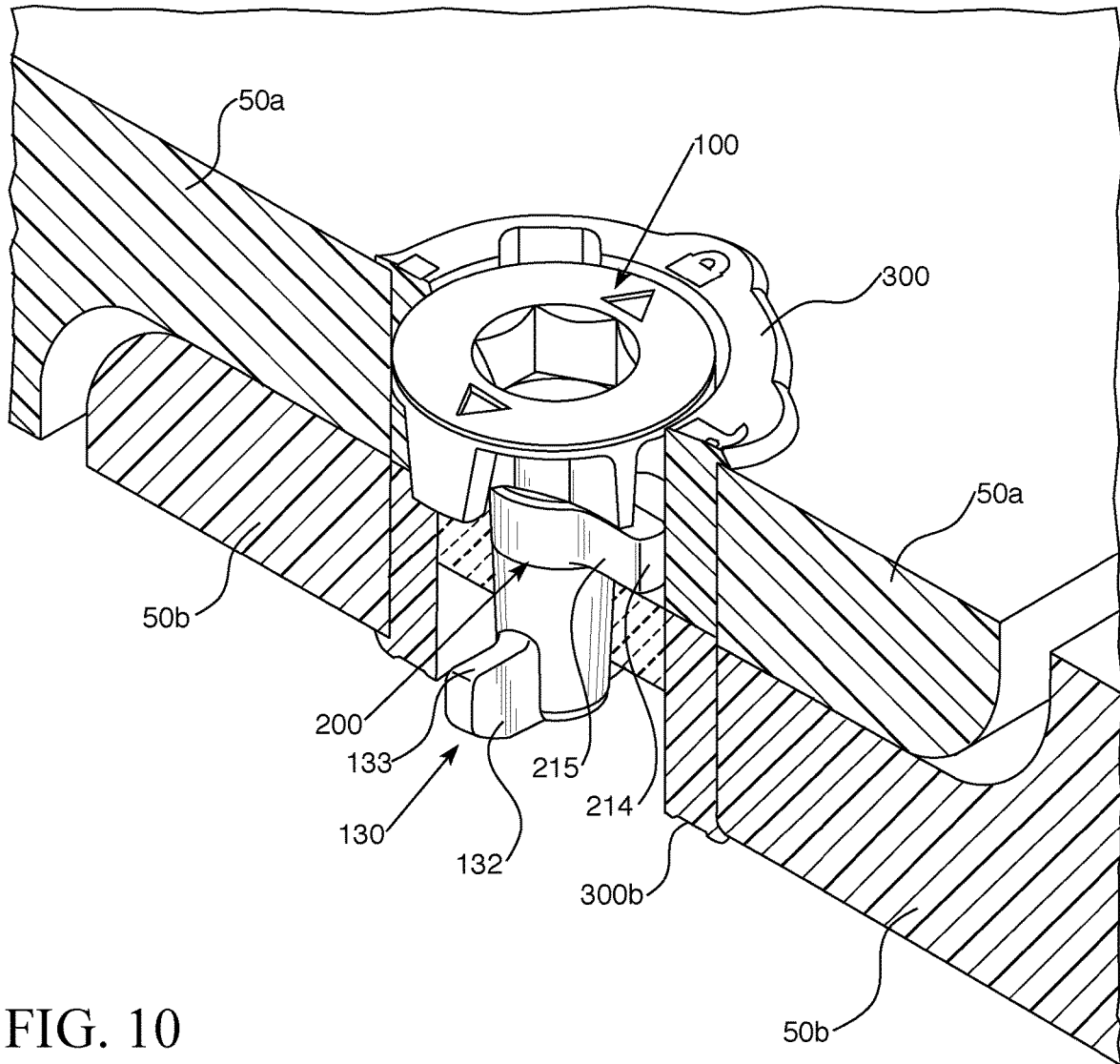


FIG. 10

1

CONNECTOR PIN

FIELD OF THE INVENTION

This invention relates to fasteners, and more particularly, to fasteners used to connect modular flooring mats for temporary roadways and flooring.

BACKGROUND

Modular flooring mats and systems are commonly used in industrial, construction and event applications to provide temporary roadways or flooring in outdoor or indoor environments. These temporary floors are assembled from a plurality of modular floor mats connected to one another in adjacent and/or overlapping fashion. There are a wide variety of ways known to connect such floor mats in assembling a temporary flooring, including fasteners such as cam locks and pins which rotate between locked and unlocked positions. For example, in U.S. Pat. No. 7,303,800 discloses a locking mechanism comprising an offset cam lock and receiver in which the lock rotatably engages the receiver, turning prongs extending from the pin to engage with laterally oriented ledges in the mat. Thus, the prongs of the rotatable pin restrain or hold the lock in position. In U.S. Pat. No. 8,388,291, a mat lock pin is disclosed for releasably holding mats together. The lock pin includes a rotor having feet that, when the rotor is turned, brings the feet to bear against the outer surface of the mat, creating axial forces that hold the mats together. In U.S. Pat. No. 8,414,217, a cam lock and complimentary receiver are mounted in floor mats such that they mate and provide a compressive force to interlock adjoining mats.

U.S. Pat. No. 6,722,831 discloses a fastening device for connecting two overlapping mats with a pin insertable into aligning holes of the mats. The pin has a longitudinal bore extending throughout through which a rod extends. The rod shaft ends in a keeper and is rotatable relative to the surrounding pin with an Allen wrench to move the keeper from being aligned with the pin to being perpendicular to the pin for a locked position. The pin includes recesses that correspond to raised ridges in the shaft of the rod. The raised ridges are seated within the recesses of the pin and prevent free rotation of the rod within the pin body. However, these recesses and corresponding raised ridges are of geometries that require significant force to overcome and move between locked and unlocked positions.

With these and most other known fasteners for modular floor mats, the process of assembling the temporary flooring is time-consuming and laborious. It typically requires two people working together to position and lay the mats relative to one another, place the fasteners, and both people to collectively turn a large dedicated tool similar to an Allen wrench to provide enough force to rotate the cam locks and secure each fastener. This provides a secure fit between the mats so they do not come apart during use, such as by being shaken or rattled as vehicles and people travel repeatedly over the mats. However, it also means it can take hours to days to install a complete modular flooring system. It would be beneficial to have a modular mat and/or connector that was easier and faster to install while not sacrificing a secure connection.

SUMMARY

A pin for connecting adjoining floor mats is disclosed which reduces the time and energy necessary to assemble

2

and install modular flooring mats. The pin of the present invention allows for easy turning between locked and unlocked positions such that a single person can lock or unlock the pin. Despite the ease of use, the geometries of the pin are such that it provides sufficient frictional forces to retain the pin in the locked position and prevent it from being inadvertently rotated out of a locked position, such as from vibration from traffic along the modular flooring system.

The pin of the present invention includes a head at a first end and a foot at an opposite second end, with a stem extending therebetween. The head includes a recess configured to receive an Allen wrench or similar tool to facilitate turning of the pin to change between unlocked and locked positions. The foot has extension member(s) extending outwardly from the foot that coordinate with the surrounding mat(s) to hold the mats together when the pin is locked. A portion of the pin stem defines a neck that includes a plurality of sections collectively forming a pattern or relief, such as but not limited to planar sections arranged adjacent to one another to form edges where they join. In at least one embodiment, there may be sixteen planar sections providing a hexadecagonal configuration of the neck.

The pin also includes a retention member engaging at least a portion of the pin in a frictional fit to retain the pin in a particular position. The retention member includes a collar correspondingly configured to the neck of the pin stem. In at least one embodiment the retention member is formed around the pin as a mold such that the collar and stem are complementary in shape with one another. Accordingly, in at least one embodiment the collar of the retention member also has a multi-sided such as hexadecagonal configuration or cross-section similar to that of the neck of the pin. The corresponding geometries of the collar and neck are such that a frictional fit is formed therebetween, the collar restricting rotational movement of the pin neck relative thereto until sufficient force is provided. Once sufficient force is provided to overcome a threshold level, the collar or neck may be configured to temporarily deflect and permit selective movement of one relative to the other, such as by rotation, until the geometries again catch on one another and form a frictional fit. In at least one embodiment, the retention member is made of more resilient material than the pin and the collar temporarily deforms to permit movement of the neck relative thereto.

The retention member also includes at least one arm extending from the collar which is configured to be retained within corresponding pocket(s) of the channel formed in mat(s) to receive the pin and surrounding retention member. The arm(s) prevent movement of the retention member in the channel, such as rotational motion, even when rotational force is applied to the pin. The arm(s) therefore help the retention member remain stationary within the channel despite movement of the pin. However, the retention member is not needed to hold or maintain the pin in the channel which connects adjoining or overlapping mats. Rather, the retention member only holds the pin in a particular rotational position, such as locked or unlocked, irrespective of the surrounding mats.

The locked and unlocked positions may be defined by the angular relationship of the extension members of the pin foot relative to the arms of the retention member. In at least one embodiment the extension members extend along a foot axis and the arms extend along an arm axis, where the foot and arm axes are spaced apart and parallel to one another. An unlocked position may be defined when the extension members are aligned with the arms. A locked position may be

3

defined when the extension members are misaligned from the arms. In at least one embodiment, a locked position may be defined when the extension members of the foot are positioned perpendicular to arms of the retention member.

Each mat of a modular flooring system includes at least one, preferably a plurality of channels formed therein and extending through the mat from one surface to the opposite surface. Each channel is configured to receive and retain a pin therein. The channel includes an opening which may be at or below the level of the mat surface and is dimensioned to receive the pin therein in an unlocked position. The channel extends away from the opening into the mat. The channel includes at least one pocket configured to receive and restrain the arm(s) of the retention member of the pin. The channel also includes at least one ramp configured to engage the extension member(s) of the foot of the pin, such as upon rotation and to achieve and maintain locked position(s). Accordingly, the channel is dimensioned to permit the pin to selectively rotate therein when moving between an unlocked and locked positions, while restricting rotational movement of the retention member. In at least one embodiment, a receiver may be selectively inserted into a bore formed in the mat. In such embodiments, the receiver includes the channel. Each mat may include its own receiver such that the channels thereof are aligned in registry with one another when the mats are overlapped, and the receivers therefore also align in registry and abut one another. In certain embodiments, the bores of the mats align in registry when the mats are overlapped and a single receiver extends through the aligned bores of both overlapping mats. In at least one embodiment, the ramp of one mat is configured to receive and retain the foot of a pin inserted through the opposing mat, thus securing the overlapping mats together. This ramp may be in the aligned receiver when two receivers or channels are present, or may be in the ramp furthest from the opening when a single receiver or channel extends through both overlapping mats.

The connector pin, together with its particular features and advantages, will become more apparent from the following detailed description and with reference to the appended drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of a connector pin of the present invention in a first unlocked position.

FIG. 2 is an isometric view of the pin of FIG. 1 in a second locked position.

FIG. 3 is an isometric view of the pin of FIG. 1 without the retention member, revealing the neck.

FIG. 4 is a cross-sectional view of FIG. 3 along line 4-4.

FIG. 5 is a top view of the retention member.

FIG. 6 is a top plan view of overlapping mats showing a plurality of receivers for connecting adjacent mats.

FIG. 7 is a top isometric view of the connector pin of FIG. 1 aligned with a corresponding receiver in one of joining floor mats.

FIG. 8A is partial cross-sectional view of the receiver and floor mats of FIG. 7 showing the details of one embodiment of the receivers and channel.

FIG. 8B is a partial cross-sectional view of the receiver and floor mats of FIG. 7 showing the details of a second embodiment of a single receiver and channels.

FIG. 9 is an isometric, partial cross-sectional view of the pin positioned within a corresponding receiver in an unlocked position.

4

FIG. 10 is an isometric, partial cross-sectional view of the pin and receiver of FIG. 9 in a locked position.

Like reference numerals refer to like parts throughout the several views of the drawings.

DETAILED DESCRIPTION

As shown in the accompanying drawings, the present invention is directed to a connector pin 100 that can be inserted into a channel 310 to join adjacent and/or overlapping floor mats 50 together to form a modular or temporary flooring system. As shown best in FIGS. 1-3, the pin 100 includes a first end 104 forming a top or head of the pin 100 and an opposite second end 106 forming a bottom or foot of the pin 100. At the first end 104, the pin 100 includes a head 110 having a face 112 and a recess 114 formed therein. The head 110 may have any suitable shape and dimension. In at least one embodiment, the head 110 is round and is dimensioned to fit within an opening 302 of a channel 310, discussed in greater detail below. A recess 114 extends away from the surface 112 of the head 110 by a portion of the depth of the head 110. In some embodiments, the recess 114 is not limited by the depth of the head 110 but rather extends through the pin 110 from the first end 104 to the second end 106. The recess 114 may be of any shape but in at least one embodiment is a hexagonal shape dimensioned to accommodate an Allen wrench of the kind and size used to install modular floor tiles, such as by insertion of the Allen wrench into the recess 114 and turning to rotate the pin 100 between locked and unlocked positions. The head 110 may include markings or indicia, such as but not limited to arrows, geometric shapes, pictorial images, drawings, logos and words, to indicate the position of the pin 100 within a channel 310 or receiver 300. In a preferred embodiment, the surface 112 of the head 110 includes indicia marking unlocked and locked positions, such as but not limited to arrows and/or an image of a lock that is locked or unlocked.

The pin 100 further includes a stem 120 extending from the head 110 at the first end 104 to the second end 106. In at least one embodiment, the stem 120 may have a smaller diameter than the head 110, but in other embodiments the stem 120 and head 110 may have similar diameters. The stem 120 terminates in a foot 130 located at the second end 106 of the pin 100. The foot 130 may include at least one extension member extending radially outwardly from the stem 120. For instance, in the embodiment shown in the Figures the foot 130 includes a first extension member 132 and second extension member 134 each extending away from the stem 120 along a foot axis 136, as shown in FIGS. 1 and 2. Each extension member 132, 134 has a length that is less than the radius of the head 110 such that neither extension member 132, 134 extends beyond the perimeter of the head 110 when viewing the pin 100 along the longitudinal axis 103. The extension members 132, 134 each also include at least one engagement surface 133, 135, respectively, which are dimensioned to interact with portions of the channel 310 of a mat 50 to hold the pin 100 in a locked position, as described in greater detail below.

The stem 120 also includes a neck 122 defined along a portion of the stem 120 between the head 110 and foot 130. The neck 122 may be located anywhere along the length of the stem 120 and may be closer to the head 110, as shown in FIG. 3, or may be closer to the foot 130 or equidistant therebetween in other embodiments. The neck 122 is comprised of a plurality of sections 124 disposed contiguously about the neck 122, as best shown in FIG. 3. There may be any number of sections 124 included in the neck 122. For

example, there may be at least six, ten, sixteen, twenty, or twenty-four sections **124**, as a few non-limiting examples. In a preferred embodiment, there may be sixteen sections **124**, forming a hexadecagonal neck **122**, such as shown in FIGS. **3** and **4**. The sections **124** collectively define the circumference of the neck **122**. The sections **124** may be arranged in any pattern around the neck **122**, which may include but is not limited to planar sections, linear sections, overlapping or intersecting patterns such as lattice structures and angled. In at least one embodiment, such as shown in FIG. **3**, the sections **124** are planar and are disposed along a longitudinal axis **103** of the pin **100**, such that edges **126** formed between adjacent planar sections **124** also extend in a longitudinal direction along the length of the neck **122**.

In at least one embodiment, each section **124** joins an adjacent section to form angled edges **126**. The included angle α of the edges **126** formed by the sections **124** depends on the number of sections **124** present. For instance, the included angle α , as shown in FIG. **4**, may be about 90° when there are four sections **124** forming four edges **126**. In other embodiments, there may be sixteen sections **124** and sixteen edges **126** forming a hexadecagon in which each edge **126** has an included angle α of about 157.5° . In other embodiments, there may be twenty sections **124** forming twenty edges **126** each having an included angle α of about 162° . In still other embodiments, there may be thirty sections **124** forming thirty edges **126** each having an included angle of about 168° . Although the embodiment shown in FIGS. **3** and **4** have equally sized sections **124** and included angles α of edges **126**, in other embodiments the sections **124** may sized differently from one another such that included angles α of edges may not be uniform throughout the neck **122**.

The head **110**, stem **120**, neck **122**, sections **124**, foot **130** and extension members **132**, **134** may all preferably be made of the same material. In at least one embodiment these components may be forged or cast as a monolithic or unitary piece. The above components of the pin **100** may be formed of any suitable material, such as but not limited to metals and metal alloys, including but not limited to stainless steel and aluminum.

The pin **100** also includes a retention member **200** dimensioned to fit snugly around the neck **122**. Indeed, in at least one embodiment the retention member **200** may be formed around the pin **100**, such as by injection molding in a die in which the pin **100** is placed. As best shown in FIGS. **4** and **5**, the retention member **200** includes a collar **210** having an inner surface **213** or circumference that is correspondingly shaped and dimensioned to the outer surface of the neck **122**. Specifically, the inner surface **213** of the collar **210** may have a similar, but slightly larger diameter than the neck **122** of the pin **100** and is correspondingly formed to the neck **122** of the pin **100**. For instance, the inner surface of the collar **210** may also include a plurality of sections that correspond with the sections **124** of the pin neck **122**. For example, when the retention member **200** is formed around the pin **100**, the sections **124** of the neck **122** dictate the inner surface **213** of the collar **210** of the retention member **200**. The inner surface **213** of the collar **210** may comprise any pattern or configuration as would correspond to the pattern, shape and/or dimensions of the neck **122** of the pin **100**. Accordingly, the inner surface of the collar **210** may also have a number of included angles α substantially similar in size, positioning and angle to the included angles α of corresponding edges **126** of the neck **122** discussed above.

The retention member **200** further includes at least one arm extending outwardly from the collar **210**. In at least one

embodiment, the at least one arm extends away from the collar **210** transverse to the longitudinal axis **103** of the pin **100**. In at least one embodiment, the retention member **200** includes a plurality of arms extending from the collar **210**. The arms may extend radially outwardly from the collar **210** by a length that is less than the radius of the head **110** of the pin **100**. The arms **214**, **216** may be positioned at any angle relative to one another along the circumference of the collar **210**. For instance, as shown in FIGS. **1**, **2** and **5**, a first arm **214** and second arm **216** extend outwardly in opposite directions from the collar **210** along an arm axis **218** defined by the path between the two arms **214**, **216**. Although two arms **214**, **216** are shown, any number of arms may be present and may extend by any length from the collar **210**, which may be the same or different lengths from one another. In other embodiments, the arms **214**, **216** may be positioned at other angles relative to one another, such as but not limited to 45° , 60° , 72° , 90° and 120° . The arms **214**, **216** may have any shape, such as a planar linear shape shown in FIGS. **1** and **2**, may be rounded, curved, curvilinear, angular or other shapes. In at least one embodiment, as shown in FIGS. **1** and **2**, the arms **214**, **216** of the retention member **200** may have similar shapes and sizes compared to the first and second extension members **132**, **134** of the foot **130** of the pin **100**. This is not a requirement, and in other embodiments the arms **214**, **216** may have different shapes and/or sizes compared to the first and second extension members **132**, **134** of the foot **130**. The arms **214**, **216** each also have at least one engagement surface **215**, **217**, respectively, which are dimensioned to interact with portions of the channel **310** of a mat **50** to hold the pin **100** in a locked position, as described in greater detail below. As shown in FIG. **5**, each side of an arm **214**, **216** may have an engagement surface **215**, **217** for bidirectional engagement.

In at least one embodiment, the arms **214**, **216** and collar **210** of the retention member **200** are preferably integrally formed of a unitary construction and from the same material. It is contemplated, however, that in certain embodiments the arm(s) **214**, **216** and collar **210** may be made of different materials from one another. It is also contemplated that in some embodiments the arm(s) **214**, **216** may be securely attached or affixed to the collar **210** to form the retention member **200**. The retention member **200** may be made of a different material than the pin **100**. For instance, as noted above, the retention member **200** is formed around the neck **122** of the pin, such as by molding. Accordingly, the retention member **200** may be made of plastic or a polymeric material as compared to the metal or metal alloy of the pin **100**. Preferably, the resiliency or “give” of the materials making up the pin **100** and retention member **200** are different. For instance, the pin **100** may be made of sturdier material that is less likely to flex or temporarily deform, and the retention member **200** may be made of more resilient material that will bend, flex or temporarily deform with less pressure than that of the pin **100**. This difference in resiliency may be slight. The resiliency of the materials may also be described in terms of hardness of the materials, which may be measured by Rockwell durometer. For instance, the pin **100** may have a hardness preferably about 60 on the Rockwell B scale in at least one non-limiting embodiment. The retention member **200** may have a hardness preferably about 65 on the Rockwell R scale in at least one non-limiting embodiment, though other hardness are also contemplated and within the scope of the device.

The collar **210** of the retention member **200** is correspondingly dimensioned to the neck **122** of the stem **120** so it fits snugly with a frictional fit against the neck **122**. The pattern

of the neck **122** may also be mirrored in the collar **210** of the retention member **200** so that a frictional grip is formed therebetween. Because of this frictional fit, and the shape or configuration of the pattern on the neck **122** and collar **210**, the retention member **200** and stem **120** are held in place relative to one another. However, sufficient force of at least a threshold amount may be applied to overcome this frictional fit and move the stem **120** relative to the retention member **200**, or vice versa. Accordingly, the stem **120** and retention member **200** are selectively movable relative to one another by the application of sufficient energy to overcome the stationary positioning such as from the frictional fit therebetween. Energy applied that is less than the threshold level does not result in movement of components of the pin **100** relative to one another. In certain embodiments, this threshold level of energy is in the range of 3 to 8 ft lbs. In at least one embodiment, the threshold level is about 5 ft lbs. In other embodiments, the threshold may be defined in other units of force, such as but not limited to Newtons (N). In still other embodiments, the threshold may be defined in terms of torque applied, such as at least 6.779 Newton meters (NM) or 5 ft lbs. Regardless of how the force is defined, the threshold level is higher than the levels typically experienced by floor mats during use, such as may be caused by vehicles or people moving over the floor mats even when carrying heavy loads. The shaking and vibration of typical use of floor mats is therefore insufficient to vibrate or rattle the stem **120** and retention member **200** enough to rotate them relative to one another.

With reference to FIGS. 6-10, each floor mat **50** includes at least one, but preferably a plurality of channels **310** extending through the mat **50** from one surface to the opposite surface. The channels **310** are positioned along each mat **50** to provide connection points between the mats **50**. Accordingly, channels **310** may be located at the corner (s) of the mat **50** and may additionally be located along the edges of the mat **50** as well. Any number of channels **310** may be located in each mat **50** and may be positioned anywhere along the mat **50**, but in at least one embodiment are positioned proximate to the corners and/or edges of the mat **50**. Preferably, each mat **50** has a similar number and positioning of channels **310**. The channels **310** may be integrally formed within the mat **50** or may be formed in a receiver **300** that is inserted into corresponding bores within the mat **50**, as shown in FIG. 7. In some embodiments, the receivers **300** may also be secured to the mat **50** upon insertion, such as but not limited to by welding, adhering, or fastening with screws, bolts, pins or other fasteners. The receivers **300** may be made of the same material as the surrounding mat **50**, such as but not limited to plastics and polymeric materials such as high-density polyethylene (HDPE) exhibiting high levels of strength. In other embodiments, the receivers **300** may be made of metals or metal alloys such as but not limited to aluminum or stainless steel.

In at least one embodiment, when adjacent mats **50a**, **50b** are aligned for attaching to one another, as shown in FIG. 8A, the channels **310a**, **310b** of each mat **50a**, **50b** align with one another. In other embodiments, as in FIG. 8B, a single channel **310** extends through both mats **50a**, **50b**. The pin **100** discussed above may be inserted into the channels **310** to lock the mats **50a**, **50b** together.

Each channel **310** has an opening **302** positioned at or near the surface of the mat **50** and into which the foot **130** of the pin **100** is inserted. For instance, the opening **302** may be flush with the surface of the mat **50** in some embodiments. In other embodiments, such as shown in FIGS. 7-10, the opening **302** may be slightly lower than the surface of the

mat **50**, such as recessed into the mat **50** by an amount sufficient to receive the head **110** of the pin **100** therein so the face **112** of the pin **100** is flush with the surface of the mat **50** when fully installed.

Regardless of the depth of the opening **302**, the opening **302** is shaped and dimensioned to receive the pin **100**, such as the foot **130**, therein. In at least one embodiment, the opening **302** is similarly shaped and dimensioned to the foot **130** and stem **120** of the pin **100**. Accordingly, in at least one embodiment as shown in FIG. 7, the opening **302** may include at least one elongate portion **304** that corresponds with the configuration of the foot **130** of the pin **100**, such as the length defined by the first and second extension members **132**, **134** of the foot **130**. Accordingly, the opening **302** may have an opening axis **308** that corresponds to the foot axis **136** of the pin **100**. In embodiments where the foot **130** is not linear and extension members **132**, **134** extend at angles relative to one another, multiple elongate portions **304** of the opening **302** may be present to accommodate the geometry of the foot **130** and extensions thereof. In certain embodiments, the opening **302** may also include a rounded portion **306** to accommodate the diameter of the stem **120** of the pin **100**, such as when the diameter of the stem **120** exceeds the thickness of the extension members **132**, **134**.

The channel **310** is in fluid communication with the opening **302** and extends away from the opening **302** into the mat **50**, such as toward the opposite surface of the mat **50**. At least a portion of the channel **310** corresponds with and extends from the elongate portion **304** and rounded portion **306** of the opening **302** further into the mat **50**. For instance, the channel **310** forms a first pocket **312** that extends from one side of the elongate portion **304** and is dimensioned to receive and restrict rotational motion of the first arm **214** of the retention member **200** by contacting an engagement surface **215** thereof. Similarly, a second pocket **314** may be formed in the channel **310** and extends from another part of the elongate portion **304** and is dimensioned to receive and restrict rotational motion of the second arm **216** of the retention member **200** by contacting an engagement surface **217** thereof. The channel **310** may have any number of pockets **312**, **314** to accommodate the various arms **214**, **216** of the retention member **200**.

Accordingly, as the pin **100** is inserted into the channel **310**, the foot **130** passes through the opening **302** and may be aligned with the elongate portion **304** and rounded portion **306** when such portions are present. Further insertion advances the pin **100** further into the channel **310** so the first and second arms **214**, **216** are received and held in the first and second pockets **312**, **314**, respectively. The channel **310** may have any depth limited only by the depth of the mat(s) **50a**, **50b**. For instance, in at least one embodiment the channel **310a** extends from the opening **302** through to the opposite surface of the mat **50a** where it aligns with a similar channel **310b** extending through the adjoining mat **50b**, as in FIG. 8A. In other embodiments, such as where the channel **310** extends through both mats **50a**, **50b** such as by a single receiver **300**, the channel **310** may also extend through both mats **50a**, **50b**, such as from the opening **302** of one mat **50a** to the opening **302** of the adjoining mat **50b**. The channel **310** may preferably be at least as deep as the length of the stem **120** and foot **130** of the pin **100**. For instance, the pin **100** may be inserted through the channel **310** until the head **110** of the pin **100** is restricted from further movement by the opening **302**, which is smaller in at least one dimension than the head **110**. For example, the opening **302** may include a recess that forms a seat for the head **110** of the pin **100**, as shown in FIGS. 8A and 8B. In the maximally inserted

position, such as restricted from further insertion by the head **110**, the foot **130** of the pin **100** preferably remains within the channel **310** and does not extend beyond the opposite surface of the collective mats **50a**, **50b**.

The channel **310** may also include at least one terminal portion **319** that is dimensioned to receive and retain the extension members **132**, **134** thereon to hold the foot **130** of the pin **100** in place in the desired position. There may be an equivalent number of terminal portions **319** as there are extension members **132**, **134** so each terminal portion **319** receives and retains a different extension member **132**, **134**. The terminal portions **319** may be substantially planar or parallel to the opening **302** and/or the surface of the mat **50a**, **50b**, although any suitable configuration is contemplated, including but not limited to dips, recesses, detents and the like. As can be appreciated from FIGS. **8A** and **8B**, the engagement surfaces **133**, **135** of the extension members **132**, **134** engage and/or push against the terminal portions **319** when the pin **100** is fully inserted and turned to a locked position. This interaction may contribute to maintain the position of the pin **100** in the receiver **300** and the adjoining mats **50a**, **50b** in association.

The receiver **300** may also include at least one ramp positioned or formed within the channel **310**, as best shown in FIGS. **8A** and **8B**. In a preferred embodiment, the channel **310** may include a first ramp **316** and a second ramp **318** spaced apart from one another along the perimeter of the channel **310**. For instance, the ramps **316**, **318** may extend along at least a portion of the channel **310** in the longitudinal depth direction of the channel **310**, the width direction around the perimeter of the channel **310**, and/or a combination thereof. For example, the ramps **316**, **318** may extend in a curved or curvilinear direction around a portion of the channel **310** in a combination of the longitudinal and transverse directions. The ramps **316**, **318** may extend toward one another, away from one another, or be parallel to one another as disposed about the interior of the channel **310**. Each ramp **316**, **318** is configured and dimensioned to receive and movably engage an extension member **132**, **134** of the foot **130** of the pin **100** thereon. There may be any number of ramps to correspond with the number and configuration of the extension members **132**, **134** of the foot **130** of the pin **100**.

Each ramp **316**, **318** may begin and end anywhere within the channel **310**, and in certain embodiments may extend the full length of the channel **310**. In at least one embodiment, each ramp **316**, **318** may begin adjacent or near the opening **302** and end at a terminal portion **319** as described above. As used herein, "near" the opening **302** means spaced apart from but still proximate to the opening **302**, and "adjacent" means at or flush with the opening **302**. The terminal portions **319** may be substantially planar or parallel to the opening **302** and/or the surface of the mat **50a**, **50b** in at least one embodiment, though they can have any configuration that would stop further movement of the extension members **132**, **134**, such as by interaction with the engagement surfaces **133**, **135** thereof.

Each ramp **316**, **318** may also have an incline angle relative to the opening **302** of the channel **310** such that the surface of the ramp **316**, **318** begins adjacent or near the opening **302** and angles toward the cross-sectional center of the receiver **300**. In embodiments in which a single channel **310** traverses both mats **50a**, **50b**, such as in a single receiver **300** of FIG. **8B**, the ramps **316**, **318** may be angled toward the center of the receiver **300** from each opening **302**. In other embodiments having matching, aligned channels **310a** and/or receivers **300a**, such as in FIG. **8A**, the ramps **316a**,

318a may extend from at or near the opening **302a** of a first mat **50a** toward the opposite aligned channel **310b** and/or receiver **300b** of the second overlapping mat **50b**. Similarly, the ramps **316b**, **318b** in the channel **310b** of the second mat **50b** extends from or near the opening **302b** toward the channel **310a** of the first mat **50a**. In either case, the ramps **316**, **318** may include a curved portion along their length as they follow the inner circumference of the channel **310**. In at least one embodiment, the ramps **316**, **318** may be mirror images of one another disposed at opposite sides of the channel **310** from one another. Each ramp **316a**, **316b**, **318a**, **318b** may include a terminal portion **319a**, **319b**, respectively, to interact with engagement surfaces **133**, **135** of extension members **132**, **134** to prevent further movement in an axial direction, such as along the length of the channel **310a**, **310b** and/or the longitudinal axis **103** of the pin **100**.

The incline angle of the ramps **316**, **318** may be any angle between 0° and 90° , such as but not limited to 45° . Because the foot **130** of the pin **100** moves along the ramps **316**, **318**, the incline angle is preferably sufficient to provide compressive forces against the mats **50a**, **50b** when the pin **100** is rotated toward the terminal portion **319** to a locked position. When the foot **130** reaches a terminal portion **319** of the channel **310**, such as at the end of the ramps **316**, **318**, the pressure of the foot **130** against the terminal portion **319** holds the mats **50a**, **50b** together.

To join adjacent mats **50a**, **50b**, the mats **50a**, **50b** are positioned next to and/or partially overlapping one another, as shown in FIGS. **6** and **8A-10**. The channels **310a**, **310b** of respective mats **50a**, **50b** are aligned with one another, or a single receiver **300** having a single channel **310** is positioned through both mats **50a**, **50b**. A pin **100** is then inserted into the channel **310** by first inserting the foot **130** through the opening **302**, as depicted in FIGS. **7-8B**. For insertion, the pin **100** is in the unlocked position shown in FIGS. **1** and **8A-9**. In this unlocked position, the foot axis **136** of the pin **100** is parallel to the arm axis **218** of the retention member **200** and the elongate portion **304** of the opening **302** of the channel **310a**. Insertion progresses by inserting the foot **130**, then stem **120** and retention member **200** into the channel **310a** then opposing channel **310b**. The pin **100** may be inserted until it is not longer capable of further movement into the channel **310a**, such as when the head **110** is stopped by the narrower opening **302**. In this position, the foot **130**, specifically the extension members **132**, **134**, are received by, or at least aligned with, the ramps **316**, **318** in the opposing channel **310b**. The arms **214**, **216** of the retention member **200** are retained within the pockets **312**, **314** of the channel **310a**. This unlocked position is shown in FIGS. **8A** and **9**.

To lock the pin **100**, force is applied to the pin **100** sufficient to overcome the threshold level and selectively move at least one of the stem **120** of the pin **100** and retention member **200** relative to one other. In at least one embodiment, this force is applied by inserting an Allen wrench or other suitable tool into the recess **114** at the head **110** of the pin **100** and applying rotational force or torque to the tool. Once sufficient force is applied to overcome the threshold level, the frictional grip of the collar **210** on the neck **122** is released and the stem **120** rotates relative to the retention member **200**. In this embodiment, the stem **120** rotates since it is connected to the pin **100** which is receiving the rotational force. The retention member **200** is held stationary by the first and second arms **214**, **216** within their respective engagement surfaces **215**, **217** contacting and pressing against the first and second pockets **312**, **314** of the channel **310**, which are configured to retain the arms **214**,

11

216 in position and resist rotational movement. The collar 210, which is made of a more resilient material than the pin 100, temporarily bends or deflects to allow the neck 122 to move out of frictional engagement and rotate relative to the collar 210. Once the neck 122 has slipped out of frictional engagement with the collar 210, the collar 210 resumes its original shape. The rotation of the stem 120 relative to the collar 210 continues until the pattern at the interface between the outer surface of the neck 122 and the inner diameter of the collar 210 cause the neck 122 and collar 210 to catch on one another again in a new frictional fit or grip, such as when the next edge 126 of the neck 122 catches on the collar 210. Continued application of force exceeding the threshold level may drive further rotation of the stem 120 within the retention member 200 until the force is reduced below the threshold level.

In the embodiment described above, the applied force may be rotational force. It is also contemplated that non-rotational force may be used in other embodiments, such as but not limited to linear force in at least one direction. In addition, though it is described that the force is applied to the head 110 or stem 120, it is also contemplated that in other embodiments the force may be applied to the retention member 200 in addition to or instead of the head 110 of the pin 100. In such embodiments, the retention member 200 may rotate relative to a stationary pin 100. The pin 100 may be made of slightly resilient material and the retention member 200 may be more rigid, in which case the neck 122 of the pin 100 may temporarily deflect or bend to let the collar 210 of the retention member 200 move past and then return to its original shape once past. In still further embodiments, both the pin 100 and retention member 200 may move relative to one another, and either may be made of resilient material to accommodate selective movement of the other when sufficient force exceeding the threshold level is applied.

During rotation, the extension members 132, 134 move along the ramps 316, 318, respectively, until each reaches a terminal portion 319. As the extension members 132, 134 progress, the incline angle of the ramps 316, 318 draws the extension members 132, 134 along the same angle, providing compressive forces against the mats 50a, 50b.

The pin 100 may be rotated until a locked position is achieved. There may be any number of locked positions, such as one for each discrete formation in the pattern at the interface between the outer surface of the neck 122 and the inner surface 213 of the collar 210. For instance, there may be a locked position for each of the sections 124 or edges 126 of the neck 120. In the case of a hexadecagonal neck 120, there may be up to sixteen possible locked positions. Of course, there may be fewer locked positions than the possible discrete positions based on the pattern at the neck 120. For instance, a pin 100 having hexadecagonal neck 120 may still only have one, two, three, four or other number of locked positions. The locked positions may be dictated by the number of rotations of the Allen wrench or other tool used to apply force to the pin 100. For instance, in at least one embodiment, the locked positions may be defined by a number of rotations or fractions of a rotation of an Allen wrench or similar tool, such as a quarter of a turn, half a turn, an entire turn, or multiple turns. In at least one embodiment, as little as a quarter of a turn on an Allen wrench or similar tool is needed to navigate from an unlocked to a locked position.

Regardless of how achieved, the locked position(s) may be defined when at least one extension member 132, 134 of the pin 100 and at least one arm 214, 216 of the retention

12

member 200 deviate from one another, such as when they become misaligned or no longer parallel. They may be disposed at any angle relative to one another in a locked position, which may be informed or dictated by the pattern(s) or sections 124 and/or edges 126 of the neck 122. In at least one embodiment, a locked position may be defined by the extension member(s) 132, 134 and arm(s) 214, 216 being perpendicular to one another as shown in FIGS. 2 and 10. This may provide optimal secure fit of two adjacent floor mats 50a, 50b. The locked position may also occur when the extension members 132, 134 have reached the terminal portions 319 of the ramps 316, 318 such that maximum compressive forces are applied to the mats 50a, 50b.

In a locked position, the arms 214, 216 of the retention member 200 are held within the pockets 312, 314 of the channel 310 in the receiver 300. The collar 210 in turn holds the neck 122 of the pin 100 in place because of the frictional fit therebetween. Notably, the frictional engagement that holds the pin 100 in the locked position is between the components of the pin 100 themselves rather than with the mat 50a, 50b, as is the case with existing connector pins. Because of this internal frictional fit, when vehicles or pedestrian traffic shake or rattle the mats joined together and locked with these pins 100, the vibrations imparted on the pin 100 do not shake or rattle the pin 100 loose from the locked position. Rather, the frictional fit with the retention member 200 holds the pin 100 in place in the locked position. The amount, intensity or frequency of vibrations from traffic or other use of the mats do not rise to the threshold level of friction necessary to overcome the frictional fit between the neck 122 and the collar 210, and therefore the collar 210 holds the neck 122 in place. The pattern or configuration of the neck 122 and collar 210 results in this frictional fit that resists movement short of the threshold level.

When it is desired to disconnect the mats 50a, 50b, the Allen wrench or other tool may again be inserted into the recess 114 at the head 110 of the pin 100 and rotational force applied. Force may be applied in the same or opposite rotational or angular direction as was applied to move to a locked position, depending on the embodiment. In at least one embodiment, force is applied in the opposite direction from locking. Once sufficient force is applied to overcome the frictional force between the neck 122 and the collar 210, the collar 210 temporarily deflects and permits the neck 122 to move or rotate relative thereto until the pattern, such as sections 124 and/or edges thereof pause or stop the movement. Overall movement of the pin 100 relative to the retention member 200 stops when the applied force falls below the threshold level of the frictional force between the neck 122 and the collar 210. This force may be repeatedly or continuously applied until the pin 100 is once again in the unlocked position shown in FIG. 9, at which point it may be removed from the channel 310. The mats 50a, 50b are now no longer connected and can be separated for transportation, storage or reuse.

The pin 100 of the present invention provides several benefits over existing known mat connectors or fasteners. For instance, the pin 100 may be turned to a locked position with less force than other fasteners, such as that disclosed in U.S. Pat. No. 6,722,831. The particular geometries of the neck 122 of the stem 120 and collar 210 of the retention member 200 are such that sufficient friction is created to avoid inadvertent rotational movement of one relative to the other, such as may be experienced by the mats from vibrations during vehicular or pedestrian traffic thereon, and yet the threshold level of force necessary to override this

13

frictional fit is not as much as other fasteners require to turn. In embodiments of the present invention where the sections 124 of the neck 122 are planar, for example, the edges 126 formed where adjacent sections 124 meet are not ridges or extensions from the neck 122. Likewise, the correspond- 5
ingly shaped inner diameter of the collar 210 does not include recesses like those of '831 patent. The ridges of the locking cylinder and corresponding recesses of the surrounding pin body in the '831 patent provide more than just a snug fit with one another. Because the ridges extend into 10
and are retained within the recesses, significantly more force is required to overcome this configuration and move the ridges out of the recesses than is required by the pin 100 of the present invention where there are no recesses or corre- 15
sponding members extending therein. Rather, the sections 124 of the neck 122 are frictionally held by the correspond-
ingly shaped inner diameter of the collar 210.

This geometry, specifically in embodiments where the sections 124 of the neck 122 are planar, unexpectedly 20
provides this resistance to inadvertent rotational movement. A recess holding a similarly shaped extension would prevent movement of two pieces relative to one another, as in the '831 patent. It is far from evident, however, that angled sections would provide sufficient friction to prevent move- 25
ment of the two pieces relative to one another that results from traffic on temporary flooring mats. It is a common problem that these mats come unfastened from one another over time as they are jostled and vibrated from vehicular and pedestrian traffic. Providing tight fasteners that resist this shaking loose from one another require a significant amount 30
of force to turn, and therefore set to locked positions. This increases the time needed for installation of modular flooring structures. Making the fasteners easier to turn, however, also makes them more susceptible to the vibrational loosening discussed above. The pin 100 of the present invention 35
solves this problem without resorting to integrated configurations where one component is inserted into another. This in turn allows the pin 100 of the present invention to be more easily turned, even by a single person, which also increases the speed of modular flooring installation overall. 40

Since many modifications, variations and changes in detail can be made to the described preferred embodiments, it is intended that all matters in the foregoing description and shown in the accompanying drawings be interpreted as illustrative and not in a limiting sense. Thus, the scope of the invention should be determined by the appended claims and their legal equivalents. 45

Now that the invention has been described,

What is claimed is:

1. A pin for connecting modular floor mats, said pin comprising:

- a first end, an opposite second end and a stem extending along a longitudinal axis interconnected between said first and second ends; 55
- a head at said first end having a radius;
- a foot at said second end having at least one extension member extending along a foot axis transverse to said longitudinal axis, said at least one extension member having a length less than said radius of said head and an engagement surface configured to contact a portion 60
of at least one of said modular floor mats;
- said stem having a neck defined along at least a portion thereof;
- a retention member disposed along a portion of said stem 65
between said head and said foot, said retention member having:

14

(i) a collar disposed circumferentially around said neck, selectively rotatable relative thereto, and forming a frictional fit with said neck to restrict incidental rotation of said stem relative to said retention member; and

(ii) at least one arm extending from said collar entirely along an arm axis transverse to said longitudinal axis and by a distance less than said radius of said head, said at least one arm having an engagement surface configured to contact a pocket extending from a bore of at least one of said modular floor mats;

wherein said pocket is correspondingly dimensioned to enclose, receive and frictionally restrain said arm of said pin from rotational motion about said longitudinal axis.

2. The pin as recited in claim 1, wherein said neck includes a plurality of sections contiguously disposed thereabout, wherein adjacent ones of said plurality of sections share a common edge along at least a portion of their length and each said edge is configured to provide said frictional fit with said collar and to restrict rotational motion.

3. The pin as recited in claim 2, wherein said plurality of sections each have a length substantially parallel to said longitudinal axis of said pin.

4. The pin as recited in claim 3, wherein said plurality of sections are planar.

5. The pin as recited in claim 3, wherein each said edge has an included angle in the range of 90°-170°.

6. The pin as recited in claim 5, wherein said included angle is in the range of 155°-165°.

7. The pin as recited in claim 2, wherein said neck and said collar are correspondingly shaped.

8. The pin as recited in claim 7, wherein said neck and said collar each include sixteen sections.

9. The pin as recited in claim 1, wherein said at least one arm extends radially outwardly from said collar, said at least one extension member extends radially outwardly from said foot, and said at least one arm is positionable between being aligned and misaligned relative to said at least one extension member by selective rotation of said retention member.

10. A system for assembling a plurality of modular floor mats, comprising:

a first floor mat and a second floor mat each having at least one channel extending therethrough, said first and second floor mats configured to at least partially overlap one another such that said at least one channel of said first floor mat is aligned in registration with said at least one channel of said second floor mat;

at least one pin each having:

- (i) a head;
- (ii) a stem extending along a longitudinal axis from said head;
- (iii) an extension member extending from said stem transverse to said longitudinal axis; and
- (iv) a retention member disposed about and forming a frictional fit with a portion of said stem, said retention member disposed entirely between said extension member and said head, said retention member having an arm extending radially outwardly from said stem between said head and said extension member and transverse to said longitudinal axis; and 80
each of said at least one channel:

- (v) dimensioned to receive one of said at least one pin;
- (vi) having a pocket extending from said channel correspondingly dimensioned to enclose, receive, and frictionally restrain said arm of said pin from rotational motion about said longitudinal axis; and

15

(vii) having a terminal portion dimensioned to receive and restrain said extension member of said pin from axial motion along said longitudinal axis.

11. The system as recited in claim 10, wherein said stem is selectively rotatable relative to said retention member by application of rotational force of at least a threshold level to said pin, wherein said threshold level is sufficient to overcome said frictional fit between said retention member and said stem.

12. The system as recited in claim 11, wherein said head includes a recess dimensioned to receive at least a portion of a tool for said application of rotational force to said pin.

13. The system as recited in claim 10, wherein said pin is selectively positionable within said channel between an unlocked position defined by said extension member and said arm being aligned, and a locked position defined by said extension member and said arm being misaligned.

14. The system as recited in claim 13, wherein said extension member and said arm are parallel and in registry in said unlocked position and are perpendicular and not in registry in said locked position.

15. The system as recited in claim 10, wherein said terminal portion of said at least one channel in said second floor mat is configured to receive and restrain said extension member of said pin extending through said at least one channel of said first floor mat from a surface of said first floor mat.

16. The system as recited in claim 10, further comprising a ramp formed in said channel and configured to receive said extension member of said pin there along.

16

17. The system as recited in claim 16, wherein said ramp extends along at least a portion of a perimeter of said channel.

18. The system as recited in claim 16, wherein said first and second floor mats each have a respective surface, wherein said at least one channel extends from a respective one of said surface of said first and second floor mats, and said ramp has an incline angle relative to said surface.

19. The system as recited in claim 18, wherein said incline angle is between 0° and 90°.

20. The system as recited in claim 19, wherein said incline angle is about 45°.

21. The system as recited in claim 16, wherein said ramp of said at least one channel in said second floor mat is configured to receive and restrain said extension member of said pin extending through said at least one channel of said first floor mat from a surface of said first floor mat.

22. The system as recited in claim 21, wherein said terminal portion is located along said ramp.

23. The system as recited in claim 10, wherein said first and second floor mats each have at least one bore extending therethrough and each of said at least one channel is formed in a receiver extending through said at least one bore.

24. The system as recited in claim 23, wherein said receiver extends through a corresponding said bore of at least one of said first and second floor mats.

25. The system as recited in claim 23, wherein said receiver is one of (i) integrally formed in said first and second floor mats, and (ii) selectively insertable in said first and second floor mats.

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